Audio Limiter (for DVD)

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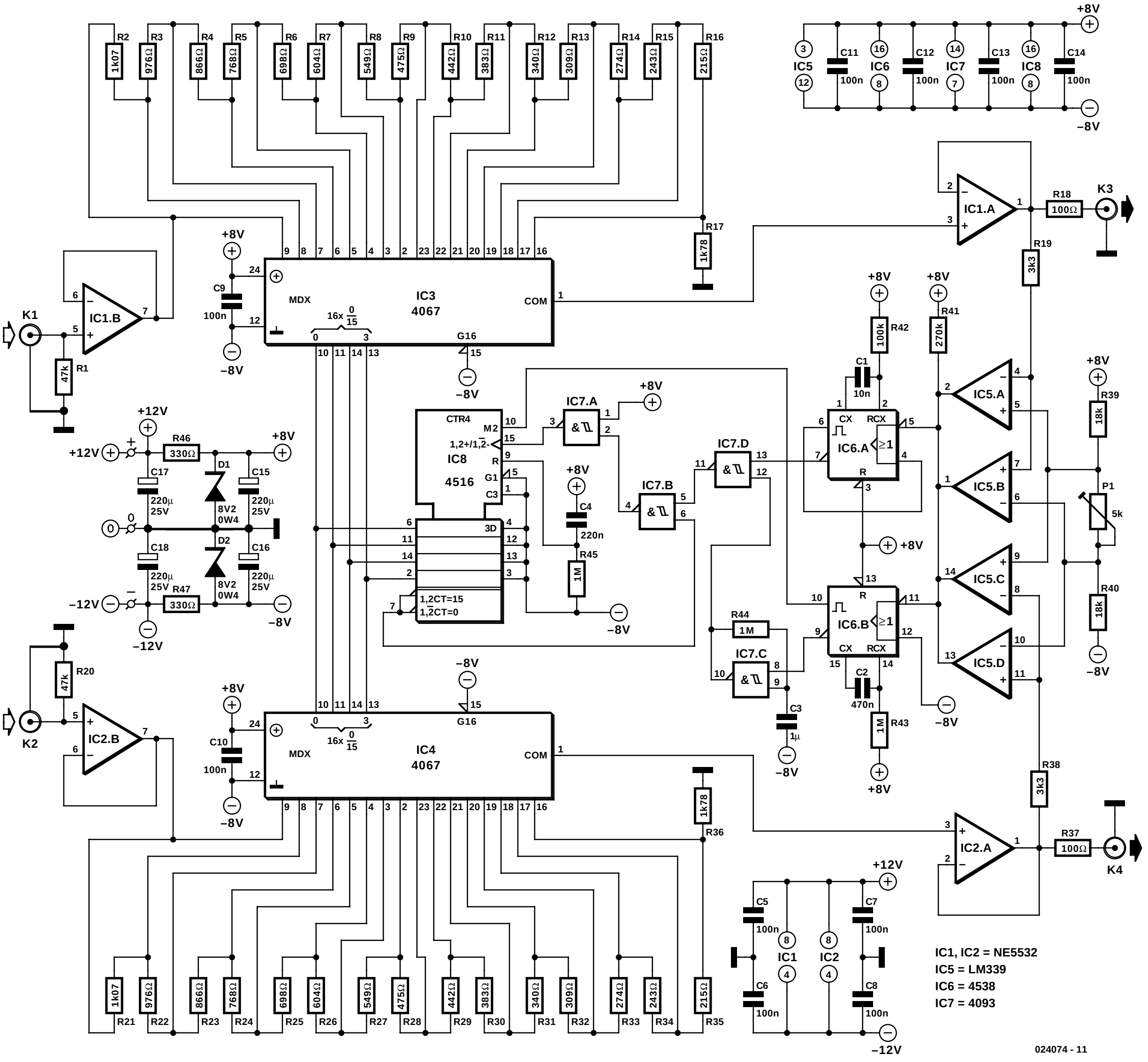
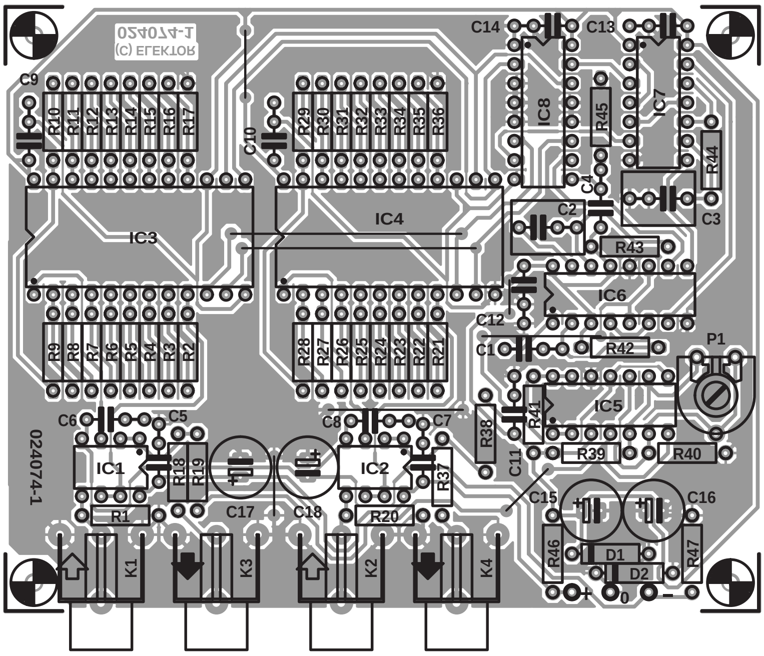
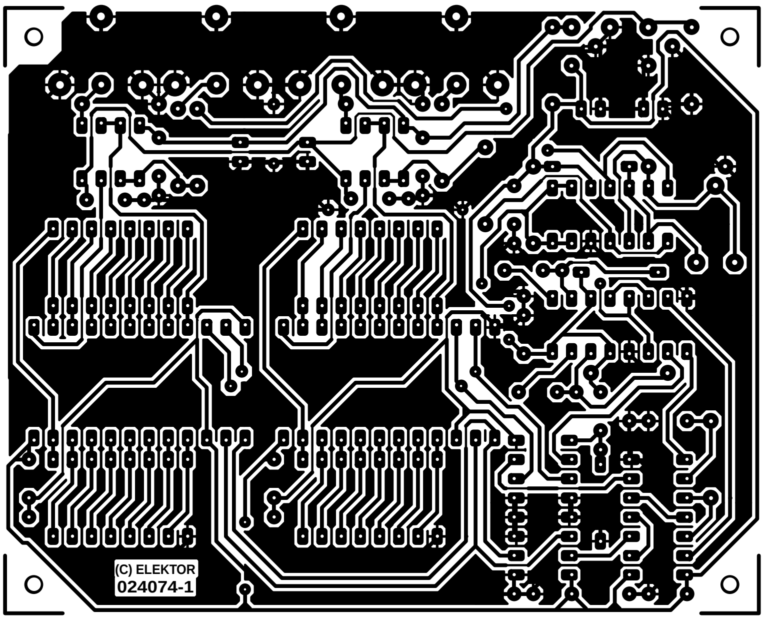
Those of you who are lucky enough to possess a DVD player and have watched a movie with lots of special effects, will certainly have noticed that the dynamic range of the audio can be very extreme. So much so that during normal use it is desirable to take steps in the form of an automatic volume limiter. If the DVD player is connected to an audio installation, then it is, in principle, not difficult to install such a limiter between the player and the audio system. It is important, of course, that the limiter does not introduce any distortion.

The audio limiter presented here limits the volume practically immediately and then slowly returns it to the normal level. The principle of operation is the same as that of a classical volume control. For each channel, the limiter comprises a voltage divider (R2 to R17 and R21 to R36) and a 16-channel analogue multiplexer/de-multiplexer type 4067 (IC3 and IC4). The voltage dividers are buffered at both the input and the output by a dual







COMPONENTS LIST

Resistors:

R1,R20 = 47kΩ
R2,R21 = 1kΩ07
R3,R22 = 976Ω
R4,R23 = 866Ω
R5,R24 = 768Ω
R6,R25 = 698Ω
R7,R26 = 604Ω
R8,R27 = 549Ω
R9,R28 = 475Ω
R10,R29 = 442Ω
R11,R30 = 383Ω
R12,R31 = 340Ω
R13,R32 = 309Ω
R14,R33 = 274Ω
R15,R34 = 243Ω
R16,R35 = 215Ω
R17,R36 = 1kΩ78
R18,R37 = 100Ω
R19,R38 = 3kΩ3
R39,R40 = 18kΩ
R41 = 270kΩ
R42 = 100kΩ
R43,R44,R45 = 1MΩ
R46,R47 = 330Ω
P1 = 5kΩ preset

Capacitors:

C1 = 10nF
C2 = 470nF
C3 = 1µF MKT, lead pitch 5 or 7.5 mm
C4 = 220nF
C5-C14 = 100nF ceramic
C15-C18 = 220µF 25V radial

Semiconductors:

D1,D2 = zener diode 8V2 0.4W
IC1,IC2 = NE5532
IC3,IC4 = 4067
IC5 = LM339
IC6 = 4538
IC7 = 4093
IC8 = 4516

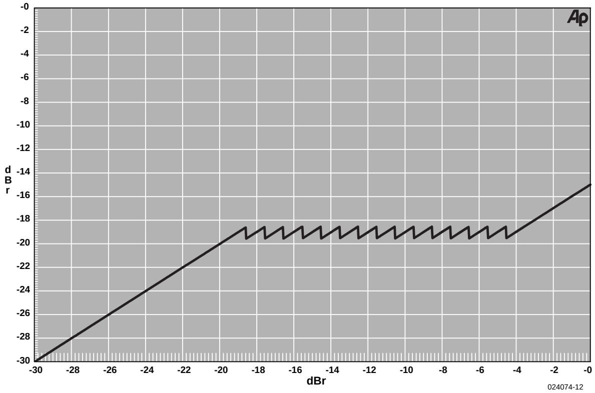
Miscellaneous:

K1-K4 = cinch (RCA) socket, PCB mount, e.g., Monarch T-709G
PCB, order code **024074-1**

opamp. The limiter has a control range of 15 dB in steps of 1 dB, which, to the ear, results in a smooth control. When the limiter is not active, the amplification is equal to 1.

The detection of the level occurs at the output with the aid of a window comparator for each channel (IC5a to d). To keep things simple, only the absolute peak value is measured and compared with an adjustable reference (R39/P1/R40). The reference voltage can be adjusted from 0 to 1 V. At the maximum output signal of 2 V_{rms} this means an attenuation of 9 dB of the maximum output voltage. The range of the limiter is intentionally limited to 15 dB, to make sure that not the entire dynamic range is removed. The best setting is that when during normal volume (a conversation for example) the limiter does not yet act, but starts to reduce the level at a few dB more than that.

The outputs of the comparators provide the trigger pluses for the two monostable multivibrators (IC6) that provide the correct drive for the binary up/down counter (IC8). We make use of the falling edges of these pulses because they are steeper. IC6a turns every trigger pulse into a 1-ms pulse for the counters. This way it is avoided that at the highest frequencies the limiter will immediately limit to the maximum amount, but that a short amount of time is required (the attack time). This design has the feature that at frequencies below 1 kHz the lim-



iter needs 15 times the period of the applied signal to limit to the maximum extent. With a pure 20 Hz signal this will take 0.75 seconds, but in practice the signal is much more complex and therefore will occur much faster.

IC6b is triggered at the same time as IC6a and has, in combination with a number of NAND-gates, a dual function. On the one hand, the counter pulses from IC6a are passed on via IC7c and IC7d whenever IC6b is active. $\overline{Q}$ of IC6b will be 'low', the output of IC7c 'high' and IC7d is enabled. In the other hand, the Q output of IC6b defines the counter direction. With every clock pulse the multiplexers will connect a lower tap of the voltage divider to the output. IC7b and IC7a make sure that the carry out (also called terminal count) prevents the counter from wrapping around (both when counting up and down). Once the input signal has reduced back down and after the period of IC6b, the oscillator IC7c will be released and the counter will count down. The time it takes for the level to start to increase is defined by IC6b and amounts to approximately half a second (t = R43 ? C2). The rate at which the increase happens is determined by the frequency of oscillator IC7c.

A few test results for completeness' sake (0dBr = 2 Vrms):

Current consumption:	± 26 mA
THD+N	
at 1 kHz :	0.0012% (0 dBr, Gain = –15 dB)
at 20 kHz:	0.0058% (0 dBr, Gain = –15 dB)
at 20 Hz to 20 kHz:	0.0054% (10 dBr, Gain = 0 dB)

R45/C4 form a power-up reset for the counter. The power supply voltage for the opamps is higher than the voltage for the digital circuitry because the opamps have a knee-voltage of a few volts at the output and have a common mode range at the input that is smaller than their power supply voltage. This way, maximum use can be made of the available voltage range of the multiplexers. The power supply for the digital section of the circuit is provided by two zener diodes D1/D2 and decoupled by R46/C15 and R46/C16, and in this way is nicely symmetric around the analogue ground level. Considering the logic levels for the trigger pulses, the comparators are also connected to the digital power supply. The total current consumption of the entire circuit is around 26 mA.

In conclusion, the adjacent graph clearly shows how the limiter influences the audio signal, because the output signal is shown as a function of the input signal with a large number of measurement points. When the input signal is slowly increasing, the output signal will follow the input until the set level is reached. Once the input signal exceeds the reference value the output amplitude is immediately reduced by 1 dB; the output then continues to follow the input until the output level reaches the reference again, etc. This will occur up to 15 times in total, at which point the output will follow the input, but attenuated by 15 dB. (024074-1)